AN ASSESSMENT OF THE STATE OF THE FOG-COLLECTING PROJECT IN CHUNGUNGO, CHILE

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I. PREAMBLE:

The question of appropriate technology for development has been a concern of theorists and practitioners for at least three decades.[1] In recent years the emphasis of the analysis has shifted from the issue of creation and diffusion of "hard" technology, to the articulation between gadgetry and "soft", social technology.[2] For instance, a relatively recent study stressed the linkage between biotechnology, venture capital, and management as fundamental factors in the success –or failure—of a technological system.[3] The notion of system is an important heuristic device that allows a nuanced perspective, relating the context to the culture, structures, processes, and effects of technology. Such perspective recognises the complex but intelligible interconnection among many factors –physical, cultural, social, political and the like—that configure what we call "technology and its circumstances"[4].

The case of the fog-collection project in the semiarid coastal area of Chungungo in Chile's "Norte Chico" (Little North) seems paradigmatic of the many cases in which a weak interconnection between contextual and operational factors apparently can transform an early success into a reputed but qualified "failure". A rather recent article in the Santiago daily, *Las Ultimas Noticias* of February 11th 2001 stated:

> The fog-catcher program was at first a daunting success; in five years Chungungo doubled its population and solved its water problem, so much so that in the outskirts of the village that until then had lived at the edge of drought, a relatively prosperous resort villa was installed...The media ...covered exhaustively the goodness of the project, stressing with scarcely disguised pride the fact that the artefacts would transform Chile into a pioneering country in the development of alternative water supply. The "Chungungo case" was the object of brilliant presentations in international seminars; even the UN started an international campaign to alert about water scarcity in that out of the way village. [5]

However, it was reported, "the fog-catchers ...are living their worst moment... Storms have destroyed more than half of these artefacts and now the community urgently is seeking a way to have a water system to address the supply problem."[6]

II. METHODOLOGY:

What happened in between the most auspicious inauguration of the project in 1992 and its virtual demise in 1997? What factors account for its collapse? This interpretative survey will attempt to provide some tentative answers to these questions by examining and co-relating a number of sources, from scientific and experimental materials, to project descriptions and assessments, to financial data, to field report, to a

series of in-depth interviews with key informants, and field visits to the sites conducted in May-June 2001.

The terms of reference of this undertaking entailed an "exploratory visit to...Chungungo... to assess the situation of the fogcatcher (sic) project" as well as interaction with "local authorities, community leaders and other key informants, to develop hypotheses about the reasons for the lack of maintenance to the fog-catching infrastructure." In particular, this survey was geared to "explore the political context of decisions to provide piped water to the village".[7]

This report is essentially an initial assessment of the current situation and the potential merit of a more detailed study. The fieldwork was budgeted to take seven days, with a final draft, originally scheduled for July 31st 2001. During Dr. Carlos Seré's visit to Santiago, it was agreed that the final report would be delivered in September 2001. However, a preliminary sketch of this report in Spanish, outlining a number of tentative hypotheses and findings was sent to the LACRO Office of the IDRC in Montevideo in late July. Upon return to Canada an in-depth interview with Dr. Robert Schemenauer, formerly of Environment Canada was conducted in Toronto (September 10th, 2000). He also provided an extensive bibliographical and reference material. Attempts to contact Dr. Derek Webb in the UK have been so far unsuccessful. The present document in English is a result of the combination of the various sources used so far.

Although the research was at thorough as possible, within the existing parameters and constraints (especially the abovementioned time limitations), there are important stakeholders and actors that were not interviewed. One was the Mayor of La Higuera (and his designate), who was unavailable during the summer visit. The other set of actors is personnel and executives at ESSCO, the regional sanitary services company of Coquimbo. The third, most important and numerous, set of interviewees are community members, especially the Junta de Vecinos. This particular segment is very important, especially since the community has been singled out as one lacking commitment, solidarity and receptivity.[8] This perception would require a degree of verification as well as an effort to see the community's side of the story.

The IDRC Office in Montevideo (LACRO) provided a fairly complete set of background documents and a list of four people who had been key players in the development and management of the project. These included two people in Santiago – Professors Pilar Cereceda, Geography Department at the Catholic University of Santiago, and Oscar Fuentes, of the Universdad Iberoamericana—and two abroad: the above-mentioned Dr. Derek Webb, and Dr. Robert Schemenauer. Both Chilean team members were contacted and extensive in-depth interviews conducted. These provided crucial information, hypotheses and also names and contacts in the field.

The names of other key prospective interviewees emerged: Mr. Waldo Canto, the Regional Director of the National Forestry Corporation (CONAF) in La Serena, Mr. Patricio Piñones, the technician in charge of water distribution at Chungungo, and Mr. Efraín Alegría, the Mayor of La Higuera, the head of the municipality to which the

village of Chungungo is ascribed. In fact, virtually everybody pointed to Mr. Canto as the most authoritative source for the inquiry.

Following phone and on site interviews with Professors Cereceda and Fuentes in Santiago, the field part of the assessment was conducted in the Coquimbo Region. The first day was in the regional capital of La Serena interviewing Mr. Canto at CONAF (the National Forestry Corporation's regional) office and establishing the contacts for the subsequent visit to La Higuera and Chungungo for additional interviews and field observation. The trip by car involved an easy ride to La Higuera and an arduous and slow trip through the coastal range in substandard and rather perilous roads, a condition that is not irrelevant to some of the findings of this report regarding water transportation and accessibility.[9]

Mr. Canto was a most valuable source of primary data, and his staff was very helpful in establishing the interviews with the water technician at Chungungo, Mr. Patricio Piñones and Mr. Cornelio Vargas, who was standing in for the Mayor of La Higuera, who was on medical leave. Unfortunately, upon arrival at the municipal seat, I was informed that Mr. Vargas had broken the appointment and travelled to La Serena and that the Mayor would not be able to see me at that time. By sheer chance, a contact with Mr. Américo Flores, the Engineer in charge of Planning for the tiny municipal head was established. He proved to be perceptible and a knowledgeable about the municipality's jurisdiction and water projects in general.

The extended conversation with Mr. Piñones in Chungungo offered a most valuable insight of things in the village –both, technical and micro political. He also provided insight into the historical and cultural characteristics of the settlement and the effects of the project upon its population, as well as the local circumstances accounting for its becoming undone.

III. THE HISTORICAL CONTEXT:

La Higuera is a small inland town of former miners and "pirquineros" (self-employed mineral ore scavengers), with reportedly high unemployment, assisted by government projects and public works. It is located some 60 kilometres North of La Serena, off and East of the Pan-American Highway. It is a municipal seat with a rather large territory to cover, mostly scattered and even smaller villages, one of which is the costal cove of Chungungo, about 20 kilometres west.

Since the 1940s, communities like La Higuera and Chungungo depended from the pole of development and employment provided by the huge El Tofo iron mine, perched high in the coastal ranges overlooking the fishing village. The operation, jointly owned by Bethlehem Steel and the state-owned Pacific Steel Corporation (CAP) produced iron ore for export to the US during WW II and inputs to CAP's steel mills, located at Huachipato, some 700 kilometres South of it. The mine's port facility at Cruz Blanca (which also housed El Tofo management and employees), is adjacent to Chungungo and supplied the town with free access to water and electricity.[10] The mine in question met the enormous demand for water (for mineral processing in large-scale waterworks) by

means of a wide 20 km-long pipe, extracting water from the Los Choros river, north of La Higuera.

Though mineral exports sharply declined after the end of the Second World War, under the policies of Import Substitution Industrialisation large amounts of ore were still required by the Huachipato steel mills, for the next three decades. In certain way, the inhabitants of Chungungo became accustomed to having water and electricity as a free good for that prolonged period of time.[11] The mine was closed as a consequence of the neoliberal restructuring of the military regime, its entire infrastructure was dilapidated or destroyed: train, waterworks, electricity-generation and machinery. Most the mine's infrastructure was scavenged by local inhabitants, and acute unemployment set in.

Chungungo, despite the loss of water and electrical services, returned to its traditional ways of artisan fishing and deep sea diving for abalone (loco) and other marine species. In many cases, these activities appear to have entailed significant poaching. The social patterns of the village appear to have been peculiar to the nature of its inhabitants' occupation. Divers and fishermen (especially poachers) are highly individualistic, with a low sense of co-operation and solidarity. On the contrary, they seem to compete for very scarce resources, with a frontier-like, zero-sum attitude.

The abalone economy (largely underground because of frequent bans to preserve the species) creates a boom and bust pattern. In the brief period of bonanza, money may appear plentiful, but it is soon evaporated, the remaining months being characterized by extreme deprivation. In fact, Chungungo was reported to be amongst the poorest localities in Chile in the 1980s and 90s, with income levels calculated at about $36 US per month[12] Without water and without a peasant tradition of its own, it was heavily dependent on "imports" of any kind of foodstuffs, other than fish and shellfish. Since the 1970s, the time of the mine closure, the town has sunk into squalor and has become severely depopulated.

IV. THE PROBLEM:

Water scarcity, especially drinking water, has been a persistent problem in most of Chile's largely desert-like North. Though not as dry as the extreme North (Regions I and II), the coastal areas of the 3rd and 4th regions posses limited water sources. There are very few rivers and underwater (fossil) water is insufficient, or very difficult to reach.[13]

Since the mid-1970s, Chungungo's water has been supplied by tank-trucks, contracted by the Municipality of La Higuera. Every 7 or 10 days, they took the slow, perilous and costly 40-kilometre road from the source at the Los Choros River to Chungungo. Though government-subsidised at a rate of 50 percent, the cost of water for the inhabitants of Chungungo was prohibitive. Water consumption per head in that locality has been estimated to be less than 14 litres per person per day and extremely unevenly distributed. It was stored in makeshift barrels in each household, under dangerous health conditions and with a deleterious impact upon hygiene.[14]

In the early 1990s the idea of providing Chungungo with an alternative and non-conventional water supply, based upon the abundant coastal fog was first contemplated. In fact, it was reportedly an afterthought of an earlier reforestation and land reclamation project initiated in the early 1980s by Chile's National Forestry Corporation (CONAF), an autonomous entity depending from the Ministry of Agriculture. Its stated mission is the preservation and replanting of forests (both for reclamation and for commercial use) throughout the country.

Most of Northern Chile's coast experiences throughout the year a persistent sea-originating, thick fog, or *camanchaca* in aboriginal language. Continuous observation by CONAF's professionals, meteorologists and the scientific community at large led to the conclusion that unless trapped by vegetation, an enormous amount of fog water ascended the coastal range and evaporated inland. A national park, Fray Jorge, under CONAF jurisdiction provided a living model where shrub vegetation, combined with bushes, small trees and large trees to produce abundant precipitation and sufficient humidity to generate a self-sustained microclimatic forest in the midst of a largely desert landscape.[15]

V. THE ORIGINAL PROJECT:

For many years and based upon existing comparative scientific data, the idea of creating an artificial equivalent to Fray Jorge had been in the minds of engineers and scientists. Professor Carlos Espinoza in Cerro Moreno, Antofagasta, had experimented with "diamond-shaped" structures to capture coastal fog. But the quantities collected were quite small and at the cost very high. Also, for a significant amount of time, physical geographers, like Professor Pilar Cereceda from the Catholic University in Santiago, had been taking measures of fog concentration and direction in and around the El Tofo area. The collected data indicated that the potential amount of water availability was enormous and that harnessing it would give a fundamental tool to re-forest a vast section of the Northern coast. The interests of both CONAF and the Catholic University converged in the preparation in 1985 of a proposal that was submitted to the IDRC for the study and development of a pilot project on fog and fog-collection[16].

The Centre sought the expertise of Environment Canada (EC) in the field of fog and Dr. Robert Schemenauer made a visit to Chile. Meanwhile, Professor Cereceda was invited as a visiting resident by EC. Reportedly, during a five-year period the federal agency contributed an amount of over $300,000, to defray expenses of personnel, lodging and transportation, as well as equipment support. In 1987 IDRC funding began and the project took off. The early idea of complex diamond-shaped structures was changed to the more efficient, simpler and cheaper device of rather common commercial plastic meshes; some of the initial designs were modified. The result was a highly efficient 4 by 12 metres (or 48 m^2) double-mesh rectangular structure, supported by a frame and firmly planted in the ground with wooden poles and tensor wires. Its construction and deployment did not require any costly or complicated equipment and the know-how required for construction was minimal and easily understandable. This contraption was able to capture in experimental runs at the El Tofo site reportedly 3.2 litres of water per square meter per day, far above expectations. It cost was also about $4,000 Canadian in 1987 values per structure, including the irrigation and storage device.[17] Considering that

Chile's northern arid coast is about 1,000 kilometres, the prospects for this appropriate technology were indeed promising.

As said above, the provision of drinking water for Chungungo was not an explicitly intended objective of the project design. Nor was within the National Forestry Corporation's (CONAF) mandate. In fact, the provision of rural water at the time was a responsibility of CORFO –Chile's Development Corporation-- by then in an acute process of restructuring along structural adjustment policies (SAP) formulas. The realisation that abundant water was obtained at the fog collectors at El Tofo, to be used by the reforestation plantation site and CONAF's cabin high in the hill, gave birth to the idea of bringing the water down to the extremely poor village below. In this, CONAF, the Catholic University and the experts agreed. The purpose changed, from water for trees to water for people. The Canadian Embassy in Santiago was also enthusiastic about this possibility and it provided the basic funding for a water-distribution system. In fact, it financed the water pipe bringing the water from the El Tofo ridge to the village.[18] However, it has been reported that at the time the IDRC was supportive only of the design and pilot project of fog-collection, but less than enthusiastic about the distribution of drinking water, preferring instead to hand in the implementation of the technological package to CONAF. Moreover, it seems that the IDRC's position was that the implementation side of the project should be as soon as possible run by Chileans -- whether through a government agency, or by the community. The other participants, such as the Catholic University and the National Forestry Corporation, increasingly shared this view. In the latter case, CONAF's Director for the IV Region was aware that his agency was well above its legal mandate in extending fog-water for tree irrigation to water for human consumption.

VI. WATER FOR PEOPLE:

The development of the water distribution (reservoir, purification and connection) component was tendered by CONAF and ESSCO to a public works contractor who, despite a few glitches, did a competent job. Yet, the new configuration was not a coherent and smooth-running system. The main question remained of how to make compatible an unconventional and non-continuous method of water collection (fog) with a distribution know-how based upon existing engineering practices in the country. There were, however, persistent problems.[19] One was the question of purification, both chlorination and filtration: the filters tended to clog up with irregular flows and most chlorination devices were constructed with a persistent flow in mind. Another problem was related to appropriate storage in the *piscinas* that were constructed. A more serious problem was that measurements done by The Sanitary Services Company of Coquimbo (ESSCO) persistently gave readings at odds with national water standards. Part of the latter problem was related to the methodology and location used to take samples. The fact remains that ESSCO laid constant fines to the village's Water Committee for not meeting such standards. There were also two less technical administrative problems: the non – existence of a permanent decision-making and management structure to handle the entirety of the operation and the enormous difficulty the Committee had in collecting payments. None of these constituted, on and of itself an insurmountable obstacle; nor were they perceived as posing a significant threat to the project.

The new water distribution system began its operation in March 1992 and was inaugurated with great display of publicity. High-ranking government officials, regional and local dignitaries, Canadian representatives and members of the NGO community and hundreds of guests were invited. The event also caught national and international media attention. Before that, and upon the having made the decision of bringing water to the village, those involved in the undertaking sought support from the local inhabitants. A social worker was hired to involve the community and to be engaged in door-to-door surveying and canvassing. Support appeared strong, though not necessarily reflecting significant, or for that matter real, community commitment, let alone involvement. There was no grass roots articulation of the water problem, or of the meaning of scarcity, or the possible venues to its solution for and by the locals. However, the support of the village's schoolteacher was elicited and a local Water Committee, with one full-time technician was established. It would be charged with the day-to-day operation and maintenance of the distribution system and with the servicing and repair of the fog collectors, 6.5 kilometres away, 750 metres up in the steep hills, at least some 20 minutes by motorized vehicle. These activities were to be financed by a portion of the water fee paid by each household to the Committee, calculated on the basis of the use registered in residential water-metres.

VII. EARLY SUCCESS:

Despite some minimal problems and "glitches", between 1992 and 1997 the project worked quite effectively. Ninety-two fog-collecting devices were built and this provided the village with abundant water. Not only there was water for basic household use, but also gardens, vegetables and flowers sprouted in an area that was essentially barren and had minimal vegetation.[20] With water flowing, regional authorities brought electricity and one public telephone to the community. This certainly entailed a quantum leap from the squalor in which the time had sunk after the end of the adjacent mine. At the level of management, the alliance between CONAF, the Catholic University and the IDRC (in conjunction with Environment Canada and with Canadian Embassy support), provided some kind of coherence and early impetus to the project. Yet this complex leadership and effort could not be sustained.

On the one hand, there was the issue of coordination between the National Forestry Corporation (CONAF), which managed the pipeline from the collectors to the reservoirs, and the local Water Committee responsible mainly for the distribution from the reservoir to the village. From the beginning, there was no one single authority looking over the entire system, whether top to the bottom, or vice versa.

On the other hand, there was the enormous difficulty in CONAF's successfully transferring the operation to any other authorities, be those the Municipality of La Higuera (from which Chungungo depends), or the ministerial and regional bureaucracies. When CORFO, which in theory was responsible for rural water, was first approached, it took nearly a year for it to report back that the jurisdiction had now been passed on to the Water Bureau in the national Ministry of Public Works.[21] The latter, in turn, had assigned the direct operation of "rural waters" to the regional public Sanitary Service Company of

Coquimbo (ESSCO). This agency, in turn, was in a state of reorganization towards privatization and, in the midst of the uncertainty resulting from profound changes an imminent privatization. It did not seem to be prone to manage an unconventional technology, choosing instead the role of supervising and sanctioning water-quality standards.

As for the Municipality, there was not a sustained interest in the project, which was persistently perceived as "odd patchwork", preferring instead a proven formula: water pumped about 20 kilometres north, at the Los Choros river,[22] as it has been the case since the opening of El Tofo mine. Moreover, for the municipal authority, the stakes involved in fog collection may have been too small, while procuring "real" water by conventional means was both impressive and a source of a political multiplier effect. It meant apparently not only the improvement of water supply for La Higuera itself, but also a symbol of high-level support for the authorities and, most importantly, a source of public-work jobs for its inhabitants. The issue here there seems to have been not so much the cost involved in supplying water, but reliability of supply and ability to deliver. The cost of trucked water was quite high –enormous in relation to the income of local inhabitants: about $2 a day on the average. Meanwhile, fog water –when the system was working—run at a fraction of that (about 75 cents a day).[23] The problem was that it was not always reliable and at times the town had to depend on the trucks. Piped water from the Los Choros river, such as that enjoyed by la Higuera, entailed a substantial investment in a 20-kilometre pipeline, with pumps and relay stations. Rural water in Chile is subsidised to municipalities at 50 percent of the cost, the remaining being paid by the consumer

When CONAF, the Catholic University and the IDRC transferred the project in 1996-97, there was no one single entity that could provide unified direction. Without IDRC support, CONAF was under heavy pressure to give up. There was no follow up in planning and, most important, maintenance. Communications between the Water Committee in the village and other agencies involved became uncoordinated and finally broke down.[24] Exemplary of this was the uneasy relation with ESSCO, whose water quality control procedures not only were questioned by other stakeholders, but whose role –as mentioned-- was mainly that of slapping heavy fines to the Committee for water standards violations. This happened at the heels of a series of damaging storms, related to El Niño phenomenon. Lack of maintenance did play a central role in many of the collectors coming down. The community was not ready to self-administer and run a system that was not theirs and for which they had to pay for and also volunteer. The administrative vacuum had a paralysing effect; neglect and disrepair soon set in

VIII. THE CURRENT PREDICAMENT:

At the time of the visit to the site in July 2001, there were no gardens, no tree plantation, most irrigation work was abandoned and only 15 out of 92 original collectors were in any way standing or operational on the mountain top. Trucks, once again are the main source of Chungungo's water supply. There was apparently a great deal of frustration with the fog-collection project at the Canadian Embassy. This feeling was apparently enhanced by the embarrassment created when the Governor General requested

to visit the fog project that figured prominently among the "success stories" in the internet and the international media, but whose reality was at odds with the images. A quick visit by Embassy personnel was able to effect a change of plans and avoided such embarrassment. It was under these less than auspicious circumstances that the series of critical newspaper reports mentioned at the beginning of this document were published.

Though on the surface, the water project appeared to be in a terminal stage, the interview with the Municipal Engineer and Mr. Piñones, suggested that it is likely that the operation would be revamped and continued; at least for some time. For the Municipality, the ideal and "permanent" solution to Chungungo's water problem would be an extension of the aqueduct that links La Higuera with the traditional source of the Los Choros river.[25] The cost, of this conventional system is, however, quite high (well over 1 million US dollars) for a small municipality, especially if it is geared to address the needs of a distant, tiny and not very accessible community. At any rate, according to the Engineer, any aqueduct could not be in operation before two years. In the meantime, the Municipality envisions a mixed system of water-trucks and fog-collectors, the latter used to reduce the frequency for transporting tanks to the village. Another alternative ESSCO (the Sanitary Services Company), the Municipality and most engineers in the area could favour over fog collection is a system of seawater desalinization by means of inverse osmosis.[26] But this too is not only very expensive but also so far purely experimental. Furthermore, it requires bi-phased electrical supply (which the town does not have) and its yields are unimpressive: reportedly 50 centimetres of freshwater in 2 by 6 metres seawater well in 24 hours. Moreover, the water has to be pumped up from sea level.

There is a secondary reason to revive the fog-collectors: since their inception, the project has caught the attention of environmentalists and "ecological tourists". As mentioned, Chungungo has been immortalized in the virtual world of development and environmental concerns. In fact, shortly before my visit, a number of grade school children from the village were given international recognition by receiving an award on their town's water project and had a commendation from Chile's Minister of Education. This PR factor provides the Municipality with an added incentive to revitalize the *atrapanieblas* and turn them into a showcase, and a possible source of revenue. Therefore, and paradoxically, it seems that for the time being, there is no viable alternative to fog water, even as a temporary and complementary solution combined with trucking. The key factor remains the willingness of municipal authorities to take over the leadership in providing water to such a small constituency.

IX. FINDINGS, CONJECTURES AND HYPOTHESES:

On the basis of the documentary sources studied as well as the in-depth interviews and field visit a battery of largely tentative hypotheses to explain and understand the current predicament of the fog collection project in Chungungo has been constructed. These conjectural observations have been presented as a set of interacting factors accounting for the paradox that a project with impeccable technical and financial parameters and with extremely auspicious beginnings ended up, after five years, in a state of semi-paralysis and neglect.

1. A basic conceptual and design problem seems to have been that from its inception the project was conceived as a sound re-forestation undertaking whose parameters were changed to accommodate the objective of providing drinking water to a very poor –and poorly studied—community. In this sense, while water-collection via fog meshes did not present major difficulties, its purification and distribution were always at odds with water collection (or essentially were not addressed). From an engineering viewpoint, there was not a single, integrated and complementary system. Nor there was an "expert culture" among hydrologists conducive to designing and operating a system with a discontinuous flow of water, in particular when it came to household distribution. In fact, there were acute periods of scarcity in winter, when fog condensation occurred below the fog collectors, or when the fog was "drier", while during spring and summer water was abundant. This meant that water supply via trucks did not completely disappear, even in the "heydays" of 1992-96, constituting an additional cost to consumers with little capacity to pay

2. A related problem is that, due to the fundamentally "technical" nature of the project as first conceived, the community was not involved in any significant way in its origins and development. Rather, villagers were brought in only at the very late stages of its implementation, after the collectors and the initial phases of collection had been completed. This should be seen in the context of a community that until the 1970s was receiving free water and electricity from the El Tofo mine. From the interviews and documentary references it is safe to ascertain that the locals perceived water and electricity (even after years of paying exorbitant prices for trucked water) were free goods, the same as the ocean. Chungungo was not only a poor and problematic community, but one which became more de-developed with the closure of the mine.

3. In conjunction with the above, according to all my sources, there was not a previous systematic study –or survey—of the socio-economic and cultural circumstances in the village, this despite the fact that the early geographical explorations of the site were initiated by an Anthropologist of the Catholic University of Santiago, whose assistant then was Professor Cereceda. The only attempts in 1992-95 were centred on the hiring of a Social Worker, once the project was underway. However, this field work, though of significant quality was more professional than analytical and produced few structural parameters for subsequent social design, planning and extension.

4. The weakest point of the project seems to have been the lack of an administrative and managerial design to implement the "hard" technology part of the undertaking. Administrative weakness, lack of sustained leadership and the absence of an integrated operational and managerial structure, compounded a persistent "political" problem, related to agency jurisdiction, territoriality and vague chain of command (and the lack of coordinating and consultative mechanisms). Gravest among these operational flaws was the

inability to build and develop administrative capabilities at the grass roots, above and beyond the weak Water Committee. There seems that there was a lack of solidarity and rational cooperative action in Chungungo, which severely crippled the Committee. At one moment, there were some six to eight different stakeholders, with vague and competing jurisdictions, all in some way above the Water Committee but with little sense of overall direction. With the exiting of CONAF and the IDRC and the Catholic University latent administrative dysfunctions became manifest. Jurisdictional changes and administrative uncertainty (such as with CORFO, the Ministry of Public Works, and most importantly with ESSCO) wreaked havoc with planning, management, and control. As for the Municipality and the regional authorities, the involvement with the project was ambiguous and intermittent at best.[27]

5. Climatic problems in 1996-97 damaged the installations, namely the fog-collectors, which had been gradually falling in disrepair and poor maintenance. More than half of the 92 operating artefacts were left out of commission. Inadequate servicing proved to be a deleterious factor, especially when lack of cleaning of the meshes and lack of appropriate tension in the wires that held the frames and poles on place, facilitated the fall of the structures. The availability of labour to do basic maintenance proved to be a persistent problem. Most men in the village were not willing to volunteer, or to work for the salaries offered. However, local women were more inclined to accept these wages. Little analysis was done of the differential gender-related behaviour. The fact that water consumption was metered and charged to its users (albeit subsidised at 50% of its cost) was an irritant; alongside the fact that supplies were not constant and that water trucks still played a crucial role. An ambiance of persistent communal bickering, affecting directly the local Water Committee, made difficult the operation of the system.

6. According to virtually all the interviewees the project was in part a victim of its own early success. First, following its highly publicized inauguration and the attempts to expand tourism (for instance, Villa Canada), a growing influx of population –both local and tourists— put strenuous demands on the water supply, to the point of collapse. The project had been designed assuming a population of some 250 to 300 inhabitants, not 1000 to 1200 people as it happened in summer and on holidays. Most importantly, there was a phenomenal expansion of expectations. Chungungo became a "showcase" of successful appropriate technology, widely reported in the Chilean and international media, not to mention the internet. From the National Geographic to CNN, to the Discovery Channel they all had their eyes and cameras trained on the small village. The place acquired an aura of international sensationalism which gave the project a virtual life of its own, far beyond its concrete reality

7. Latent design problems, plus emerging political, administrative and social circumstances were compounded and multiplied by adverse climatic

conditions at a point in which the major players were transferring the management of the Chungungo operation to regional and local authorities. The overall effect was systemic breakdown.

X. TENTATIVE CONCLUSIONS:

In sum, two general and highly preliminary conclusions are presented. The first is more analytical in nature, though with very practical implications. The experience of Chungungo offers an excellent model to understand the complex and inter-related problems associated with the creation, development, implementation and sustenance of "appropriate" technologies. It also offers a valuable (and heuristic) insight on the numerous and at times contradictory interfaces between "hard" and "soft" (or implicit) technologies. As a case study, the understanding of Chungungo can be a useful "window" for the analysis, evaluation and learning about technology, development and extension in a concrete Third World setting. In this sense, it would be quite relevant to carry on a more in-depth and systematic study, one with promising implications as teaching and training material.

The second conclusion is more substantive: despite the manifest problems extant in the present situation, the fog collection technology appears to be an extremely promising and low-cost technology in arid or semi-arid coastal areas. This is especially the case if this technology is primarily oriented to the development of stable ecosystems. Regardless of the numerous problems related to the specific Chungungo experience, fog collection technology appears to be a viable and low-cost technology for coastal arid and semi arid areas with similar climatic conditions. Scientific data and innumerable experimental projects in Peru, Ecuador, Oman, and South Africa, to mention a few, have corroborated the Chilean findings. An important network of expertise has been formed in a truly global scope; scientific conferences, internet linkages and publications continue emerging from this research.

Even in Chile, there have been two other and apparently very successful, albeit less publicized, "private" experiences with fog collection. One is at the Shrine of Padre Hurtado, some 100 kilometres south of la Serena, by the Pan American Highway. In this case, collected water is used as a source of irrigation for vegetable gardens, whose produce is the mainstay of a restaurant run by the local priest, Father Luis Brevis[28] The other example Mr. Canto mentioned was that of a sheep farmer who used fog water from collectors to irrigate grazing plots and to provide beverage for the animals. This operation was also located south of the regional capital of La Serena and was reportedly terminated when the farmer sold the land.

All in all, and given the current state of application of the technology, it could be that this technological package is better suited to the development of sustainable ecosystems, similar to the Fray Jorge ecological reserve, rather than for the provision of a direct source of drinking water per se. The field research included a visit to the actually operating small fog collection system at the park, where its effectiveness and simplicity could be appreciated (there was very little fog at the mountain peak the day of the Chungungo visit). But, the know-how could also remain useful and highly effective in

bringing drinking water to small localities if certain conditions are met. From the Chilean experience, two general and broad ranging technological challenges that need to be overcome in future projects can be detected in this latter respect. The first is the difficulty in developing an integrated collection and distribution system, when its two basic processes remain hardly compatible. This means the practical difficulty of combining a non-continuous, open and passive water collection mechanism with the existing know how regarding water distribution, to which collection is attached. Research and design seems to be necessary in combining collection with appropriate distribution. The second difficulty is the inability of creating and maintaining a management structure (soft technology) that would allow the system as a whole to operate and sustain a learning feedback loop, with crucial decisions, assigned responsibilities and follow-ups. This means the need to develop an administrative modality that encourages participation and support by the users, who can also become self-managers and producers, while making services affordable. These two factors point in the direction of the need of more integrated research and experimentation of in both soft and hard fog collection technology, especially delivery and purification. Here there is an important task for the scientific community and for agencies such as the IDRC.

Looking at the big picture, Chungungo was by no means "a failure". An in-depth and nuanced study of the dysfunctional aspects of the project would certainly contribute to our understanding of the multiple interactions to consider in analysing technological interventions for sustainable development as they unfold in real life situations. One aspect that deserves to be highlighted is that all technologies present "life-cycles": they emerge, develop, affect changes and eventually fade away, or re-emerge as new recombined modalities. Fog collecting in Chungungo represents only a limited phase of the full capabilities of a technology, one needs to be explored fully.

The above leads to a number of suggested operational and practical considerations in design and implementation to look at "questions" and "problems" before "answers" or "solutions" are attempted. (a) The first is the necessity to make a prior socio-economic, political and cultural assessment of the "problem" in situ –in this case, water scarcity or water insecurity– from the point of view of those having the problem. (b) The second consideration is the requirement of linking the various elements of hard and soft technology in a single matrix of analysis, development and implementation. (c) The third is the incorporation of the community in the project well before its onset, empowering its members to manage and adapt the new technology to their concrete collective problem, requirements and circumstances. A "cargo cult" (or *ekeko*-like) view of technology[29] on the part of a community –in which locals are passive recipients of a gift from "above"– fosters a sense of alienation. Particularly important here is to consider the perspective not only of the managers, but the users; not only the "elite" of functionaries, experts and decision makers, but of those who experience the problem. Likewise, as the findings suggest, a need for "genderising" the analysis is fundamental. Women in the village were an important, willing, but hardly tapped resource, one whose support would have been crucial to sustained success. (d) Finally, there is the essential need of continuously monitoring the social, and politico-administrative forces behind the project, in order to

adapt it to changing circumstances, beyond the mere formal transfer of responsibilities to national, regional or local authorities.

In sum, there was no one, single and identifiable "cause" to explain the slow abandoning and exhaustion of a most promising, scientifically and financially sound project. Rather, it was a myriad of interconnected micro-factors that over time combined to bringing it down. The bulk of these factors are managerial, organisational and "micro-political". Neither these, nor the small engineering difficulties that emerged, were beyond control, or repair. Of these, the lack of a central responsible authority for the whole project and the lack of real local commitment and participation, deserve to be highlighted. Hopefully this report may have contributed to the understanding of the above-mentioned factors and of the possible ways to anticipate and prevent similar dysfunctions in the future.

References

[1] See Ernst Friedrich Schumacher, *Small is Beautiful: A Study of Economics as if People Mattered,* (London: Blond and Briggs, 1974), *passim.*

[2] See our "Science, Technology and Underdevelopment: A Conceptual Approach", with O.P. Dwivedi and J. Vanderkop, *Canadian Journal of Development Studies*, Vol. XI, No. 2, (December 1990), pp. 223-240.

[3] See our 1998 Report, "The Interface Between "Hard" and "Soft" Technologies: Biotechnology, Venture Capital, and Management in Chile. A Preliminary Report", internal circulation document prepared for the IDRC's Latin American and Caribbean Research Office (LACRO), February 26, 1998, pp. 1-2.

[4] Nef, Dwivedi and Vanderkop, *loc.cit*

[5] *Las Últimas Noticias*, February 11, 2001, pp. 2-3.

[6] *Ibid.*

[7] IDRC, Offer of Consultancy Contract Project No 100910, Contract No. 105786 (July 2001) p.1.

[8] Cf. L. Venero, "Informe Social", p. 1-2. This report, apparently by the Social Worker, is appended to the Financial and Technical Report presented by Dr. Derek Webb and Mr. Oscar Fuentes , Project No. 93-8751 (June 1996).

[9] See, Pilar Cereceda, Robert Schemenauer and Marcela Suit, "An Alternative Water Supply for Chilean Coastal Desert Villages", *Water Resources Development*, Vol. 8, No. 1 (March 1992), p.55.

[10] Robert Schemenauer and Pilar Cereceda, "Water from Fog-covered Mountains", *Waterlines*, Vol 10, No. 4 (April 1992), p. 10.

[11] Cereceda, Shemenauer and Suit, *op.cit.* p. 56.

[12] Cereceda *et al. op. cit.* p.57.

[13] See Marcela Suit, "Estudio de agua potable rural en las localidades de Chungungo y Caleta Hornos Región de Coquimbo – Chile", Thesis, Institute of Geography, Faculty of History, Geography and Political Science, Catholic University of Santiago (May 1989), p.2.

[14] See Cereceda nd Schemenauer, "La percepción de los consumidores de agua potable de nieblas costeras de Chungungo, Chile", *Revista Geografica de Chile Terra Australis* , No 38 (1993), p. 9.

[15]Corporación Nacional Forestal, "Coastal Fog Application – Chile" , IDRC Project No. 90-0202, Final Report (1993), p. 2.

[16] See S. Fahmy and R. Schemenauer "Coastal Fog Application – Chile", Project Sumary IDRC 3-P-90-0202, (1991), p. 1

[17] CONAF, *Informe Final* 1993, Annexes No. 1-4.

[18] Schemenauer and Cereceda, "Water from Fog-Covered Mountains...", p.11.

[19] CONAF, *Informe...1993*, pp. 8-23.

[20] See Marc Margolis, "With Their Heads in the Clouds", *Newsweek*, October 11, 1993, p.21.

[21]Earlier serious concerns were expressed by Derek Webb. See Webb and Oscar Fuentes, "Informe técnico y financiero" (June 1996), p. 3.

[22]See Mr. Américo Flores interview with Cristóbal Florenzano of *Las Últimas Noticias*, *loc.cit.*

[23]Calculations vary significantly, ranging from almost equal to a favourable and highly optimistic ratio when using fog-water. See for instance Cereceda, Schemenauer and Suit, "An Alternative Water Supply for Chilean Coastal Villages" , *Water Resources Development* (1992), pp. 53, 57-58.

[24]For a view of the cumbersome bureaucratic arrangement, see Cereceda *et al.* "La niebla, agua potable pare zonas rurales", *Revista Geográfica de Chile Terra Australis* , No. 45 (2000), pp143-145, also Cereceda and Schemenauer, "La percepción de los consumidores...", p. 10.

[25]Flores cited by Florenzano and interview with Flores (June 2001).

[26]*Ibid.*

[27] Cereceda and Schemenauer, "L apercepción...". p. 10.

[28]See Pilar Cereceda, Robert Schemenauer, Pablo Osses, Horacio Larraín y Cristóbal Correa, "Los atrapanieblas del Santuario del Padre Hurtado y sus proyecciones en el combate a la desertificación" FONDECYT project No. 1971248 (circa 2000), p.4.

[29]See our "Technology is about People. Basic Concepts and Definitions", in J. Nef, J. Vanderkop and H.Wiseman (eds.) *Ethics and Technology* (Toronto: Wall & Thompson, 1989), p. 7.